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EARTH ANALOGS OF PLANETARY SUBGLACIAL SITES FOR EUROPA EXPLORATION TECHNOLOGY DEVELOPMENT AND TESTING

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Europa is a most interesting moon. In particular the results of studies using the Galileo observations strongly suggest a deep, salty, subglacial ocean beneath an ice crust of thickness 5 to 30 km, and a good argument can be made that this ice is essentially sea ice in analogy with that on Earth. In further Earth analogy, the low-density (ice-ocean) skin of Europa can be considered to possess three distinct zones of possible habitability: the layer of ice in contact with the water (the basal ice), the water itself, and the layer of seafloor in contact with the water. (Arguably the Europa ocean, which may be of order 100 km deep, could be viewed as numerous distinct habitats; this level of detail is not important at this stage.) Clearly, Europa is an excellent target for exploration in the search for life, and considerable planning and discussion has gone on to develop exploration concepts. These concepts typically encounter significant difficulties in basic mission design areas such as access to the surface with scientifically useful payloads and survival on the surface for enough time to accomplish the required observations. In our activity, we have assumed that these problems have been solved and that the issues of interest are those of in-situ ice and ocean exploration. The specific issues are: mobility, instrumentation, autonomy and communication. A very significant issue, that of planetary protection, is not ignored, but resources have not yet been identified for a practical attack on this highly significant issue.

Within Earth science there is long experience with the structure, composition and biota of the ice, water, and sediment zones, and there is great variability in the nature, and particularly the geochemistry, of the zones as they are found on Earth. As it happens, no particular habitat on Earth constitutes a clear analogy with the Europa ice-water-seafloor environments, due at least in part to our ignorance of Europa. There is no guarantee that we would have an appropriate biochemical analogy even if we were not ignorant. Those who employ simple assumed conditions are working in the best traditions of science; Of course they run a great risk: nature has always amazed us in complexity.

We have embarked on evaluation, specification and development of technologies for in-situ exploration of Europa. We argue that there are natural partnerships in collaborations among Earth and space science and technologies in this area; in particular the basal regimes of ice sheets and caps of Antarctica, Greenland and Iceland are interesting sites for physical, geochemical and microbiological research relevant to climate processes and extremophile studies. We note that optimal development of these research projects logically involves collaborations with Earth scientists who are specialists in these domains. Our work to date has included mobility in ice, acquisition of data from optical probes in an ice sheet, and surface-based surveys of subglacial conditions and geometries.